National Park Service
U.S. Department of the Interior

Natural Resource Program Center

KLMN Invasive Species Early Detection Monitoring Protocol Annual Report 2009

ON THE COVER
Common mullein (*Verbascum thapsus*), one of the Klamath Network's prioritized invasive species, shown here at Lava Beds National Monument.
Photograph by: Sean B. Smith, Klamath Inventory and Monitoring Network

KLMN Invasive Species Early Detection Monitoring Protocol Annual Report 2009

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Executive Summary

The Klamath I&M program implemented its Invasive Species Early Detection Protocol for its first full season from April to September 2009. During the season, a two person crew visited all six parks in the Klamath Network, beginning in Whiskeytown NRA and concluding in Redwood NSP. The crew monitored 170 road and trail segments for a total of 395 km. The sample effort matched or exceeded expectations. We observed a total of 225 separate infestations of 26 invasive species, and collected site-specific data at 152 of these infestations. Invasive species infestations tended to occur within 6 m of a road or trail, in areas with less overstory cover, and more often along roads than trails. This represents the first quantitative sample of all six parks in the Network using a repeatable, peer-reviewed methodology at comparable intensities.

Introduction

In the late spring 2009, the Klamath I&M Network implemented its Invasive Species Early Detection Monitoring Protocol (hereafter ISED Protocol) at all six Network parks: Crater Lake National Park (CRLA), Lava Beds National Monument (LABE), Lassen Volcanic National Park (LAVO), Whiskeytown National Recreation Area (WHIS), Redwood National and State Parks (REDW), and Oregon Caves National Monument (ORCA). Results of the 2009 season are described here in the annual report format that the Network proposes to employ in future monitoring years. These annual reports are intended to 1) quickly summarize the work completed in a given field season and 2) assist park managers with targeting their rapid invasive species response efforts. We welcome feedback on the format and content of the report to help ensure future reports are optimized for usefulness to managers.

Methods

Field Preparation

Site Selection

For each park, all roads, trails, and power lines were broken into 3 km target segments for sampling. Smaller terminal sections were also included. Busy roads posing a safety threat were eliminated from the sampling frame. We then selected a random spatially-balanced sample of segments for each park using the GRTS (Generalized Random Tesselation Stratified) technique (Stevens and Olsen 2004). We chose the number of segments to be visited at each park based on criteria explained in the Klamath Network ISED Protocol (Odion et al., in revision). We set the minimal sample size (segments visited) for WHIS, CRLA, LAVO, and LABE at 25. Redwood, having the largest mileage of roads and trails, had a minimal sample size of 35. Oregon Caves, due to its small size, had a complete census of all road and trail segments performed: 11 total.

Species Selection

Klinger and Brooks (2008) conducted the invasive species prioritization on a park-by-park basis using a combination of expert opinion and peer reviewed publications. First, lists of non-native species were split into two categories: invasive and non-invasive. Non-invasive species were judged to not be ecosystem transformers and were subsequently dropped from the prioritization process. The remaining invasive species were placed into one of three categories representing phases of the invasion process: 1) colonization, 2) establishment, 3) spread/equilibrium. Species in the colonization phase were considered to be in areas adjacent to each NPS unit or they recently colonized a small portion of the unit. Species in the establishment phase had multiple, relatively small, localized populations within the boundaries of a unit. Species in the spread/equilibrium phase were more widely distributed than those in the establishment phase. Some species in the spread/equilibrium phase were dropped from the list of species to be monitored because control of these species through management actions was considered infeasible; others were to be monitored only in the backcountry (as defined by each park). Before the beginning of the 2009 season, minor modifications occurred to the prioritization lists at some parks based on new knowledge of park invaders.

Field Methods

Site Sampling

The field crew traversed each 3 km target segment, starting at the most accessible end. GPS locations and the size category of each infestation (<1 m^2, 1-25 m^2, or >25 m^2) were recorded. The segment was divided into 500 m subsegments if the number of individual species infestations for each subsegment was more than four or the entire subsegment was considered infested (for management purposes). Up to three infestations plots per segment were sampled. Plots were circular, 100 m^2, centered on the infestation, and randomized and spatially balanced among infestations when these were numerous. Crews also randomly placed one 100 m^2 plot within 6-14 m of the road or trail in each 500 m subsegment, without regard to location of infestations (Figure 1.). In each of these random plots, we sampled the vegetation and environmental variables and abundance of invasive species (if present) (Table 1).

To the degree feasible, parks were monitored at the time of maximum phenological expression for detecting invasive species. However, conditions were not always ideal for all species in all parks. For example, we were a little early for *Centaurea* spp. to be in full bloom at WHIS.

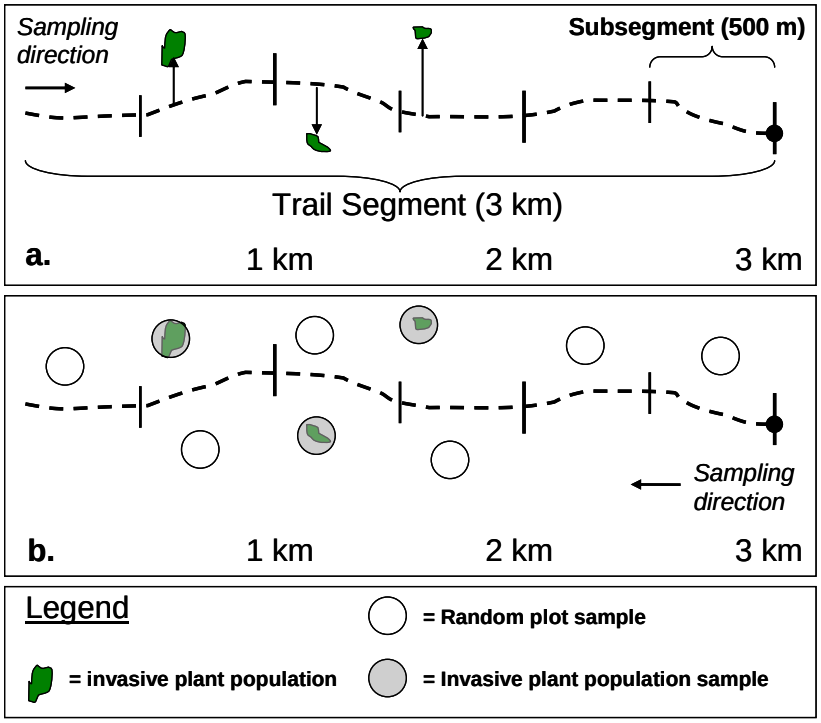

Figure 1. Schematic of segment sampling methodology.

Table 1. ISED plot measurements.

- GPS coordinates
- Infestation size*
- Infestation % of plot*
- Infestation distance from road or trail*
- Slope
- Aspect
- Average canopy height
- Soil disturbance
- Light index (measured with a densiometer)
- Phenology
- Topography (macro and micro position)
- Hydrology
- Land use
- Infestation species
- Percent cover (evergreen, deciduous, herb, shrub, woody debris, litter, bare ground, surface water, soil disturbance)

Data Collection

We recorded data electronically with a TrimbleGeoXM handheld GPS. This was also the primary source of geographical data. In cases where the Trimble could not get satellite reception, we used a Garmin 76CSX GPS unit for location coordinates. Data were also recorded at plots using paper datasheets.

Results

Productivity

We monitored 170 segments, for a total of 395 km. Roads accounted for 55.3% of surveyed segments while trails were 44.7%. We averaged 2.4 segments per day. The largest number of segments completed in one day was four. Some minor inconsistencies with GIS coverages slowed our productivity. Several road segments we attempted to survey at REDW had already been decommissioned. These segments were not completed and were removed from the sampling frame. All powerline segments at WHIS were also removed due to accessibility issues. Blue Lake Trail at LAVO was indistinguishable for the last three subsegments, so these were eliminated. One segment at LAVO that was found to be a decommissioned road was eliminated.

General Patterns of Invasive Species Distribution and Abundance

We observed a total of 225 separate infestations of 26 invasive species (Table 2) and collected site-specific data at 152 of these infestations. The most common plant families among infestations were Asteraceae and Poaceae, each with seven species. Fifteen observed species were herbaceous perennials, nine were annuals, and two were shrubs.

The majority of invasive species infestations (99.1%) occurred within 6 m of a road or trail (Figure 2) and infestations occurred more commonly along roads (79.6%) than along trails (20.4%). This difference was significant by (x^2= 8.84 on 3 degrees of freedom; p=<.01). The only two species occurring over 6 m from a road or trail were pampas grass (*Cortaderia* spp.) at 12 m and Scotch broom (*Cytisus scoparius*) at 10 m. However, these two species averaged 1.9 m and 2.3 m, respectively, from a road or trail. No invasive species were found in any random plot (n = 788).

Invasive species also were much more common at low to mid elevations. Only one infestation occurred above 1500 m, ox eye daisy (*Leucanthemum vulgare*), at 1725 m at CRLA (Figure 3).

Invasive species tended to be more common in areas with less overstory cover (Figure 4). For seven species, the plot average spherical densiometer cover was <1%. These were pinnate tansy mustard (*Descurainia sophia*), broad-leaved pepperweed (*Lepidium latifolium*), sweet clover (*Melilotus* spp.), Russian thistle (*Salsola tragus*), Medusahead (*Taeniatherum caput-medusae*), common mullein (*Verbascum thapsus*), and goat's beard (*Tragopogon dubius*). All these species occurred exclusively as prioritized species at Lava Beds. Four species occurred in plots with an average densitometer reading of >80% overstory cover; these shade tolerant species, all of which were found only at Redwood, are herb Robert (*Germanium robertianum*), tansy ragwort (*Senecio jacobaea*), foxglove (*Digitalis purpurea*), and English holly (*Ilex aquifolium*).

Table 2. Prioritized invasive species observed in the Klamath Parks, 2009.

Species	Frequency (%)	Parks
St. John's wort (*Hypericum perforatum*)	21.8	ORCA, REDW, WHIS
pampas grass (*Cortaderia* spp.)	20.9	REDW
bull thistle (*Cirsium vulgare*)	11.1	WHIS, REDW
goat's beard (*Tragopogon dubius)*	8.0	LABE
cheat grass (*Bromus tectorum*)	5.3	WHIS, REDW
fox glove (*Digitalis purpurea*)	4.0	REDW
Canada thistle (*Cirsium arvense*)	3.6	LABE, WHIS
sweet clover (*Melilotus* spp.)	3.6	LABE
Scotch broom (*Cytisus scoparius*)	3.1	WHIS, REDW
Medusahead (*Taeniatherum caput-medusae*)	3.1	LABE
red brome (*Bromus rubens*)	2.2	WHIS
pinnate tansy mustard (*Descurainia sophia*)	1.8	LABE
tansy ragwort (*Senecio jacobaea*)	1.8	REDW
knapweed (*Centaurea* spp.)	1.3	WHIS
orchard grass (*Dactylis glomerata)*	1.3	ORCA
herb Robert (*Geranium robertianum*)	1.3	REDW
soft brome (*Bromus hordeaceus*)	0.9	WHIS, REDW
English holly (*Ilex aquifolium*)	0.9	REDW
cutleaf blackberry (*Rubus laciniatus*)	0.9	REDW
ripgut brome (*Bromus diandrus*)	0.4	WHIS
broadleaved pepperweed (*Lepidium latifolium*)	0.4	LABE
ox eye daisy (*Leucanthemum vulgare*)	0.4	CRLA
himalayan blackberry (*Rubus discolor*)	0.4	REDW
common sheep sorrel (*Rumex acetosella*)	0.4	WHIS
Russian thistle (*Salsola tragus*)	0.4	LABE
common mullein (*Verbascum thapsus*)	0.4	LABE

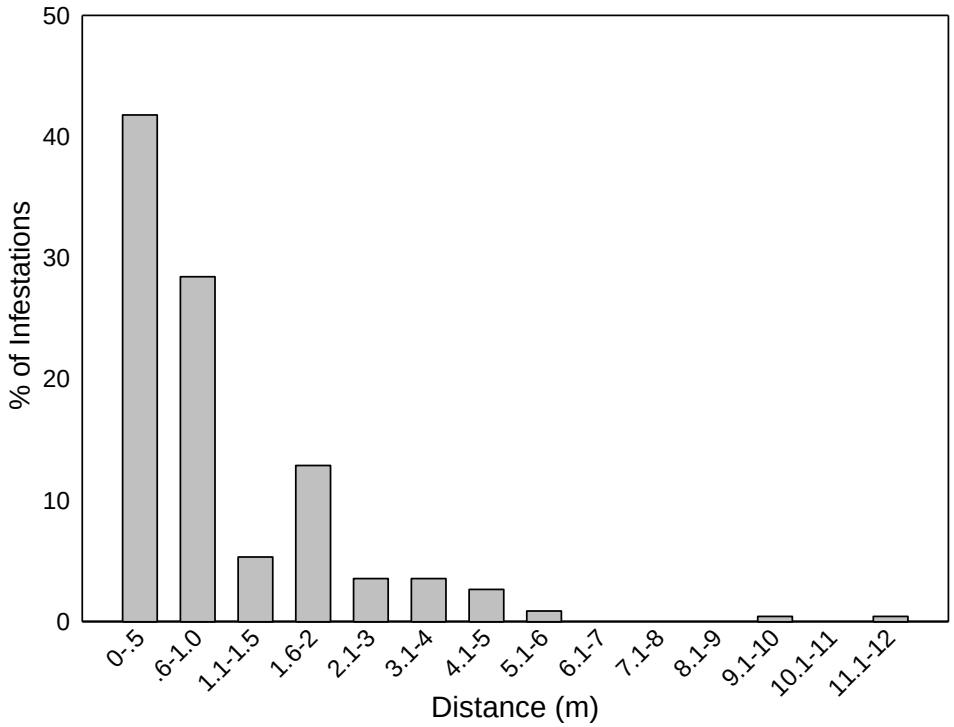

Figure 2. Percent of infestations with increasing distance (m) from a road or trail.

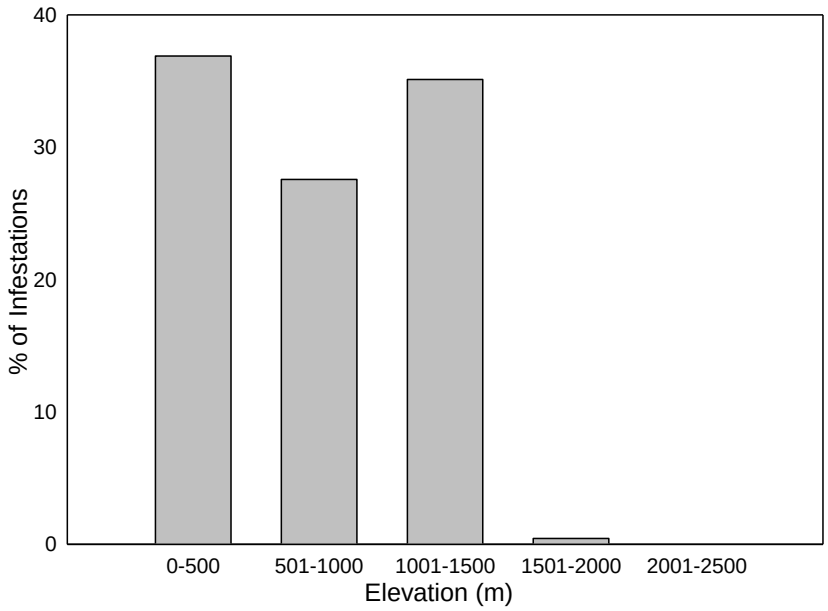

Figure 3. Percent of detected plant infestations in each elevation zone across the parks of the Klamath Network.

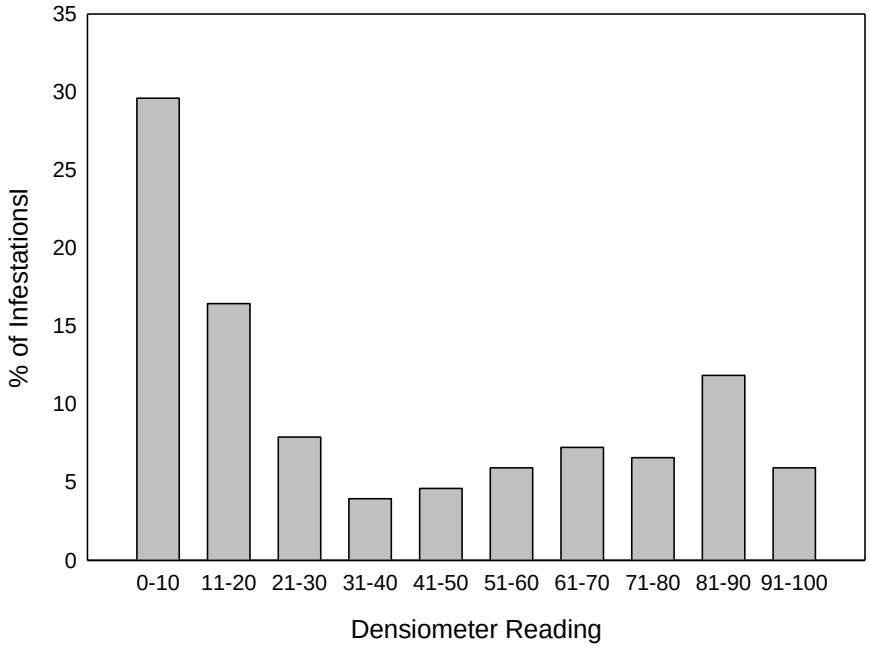

Figure 4. Percent of infestations detected by overstory cover class as measured with a spherical densitometer in all the parks of the Klamath Network

Park-specific Patterns

We encountered the highest percentage of infested segments at REDW (Table 3) and the lowest at the two high elevation parks. However, the two largely low elevation parks, REDW and WHIS, differed substantially in the number of segments infested. Summaries are provided of the primary species encountered in each park. Additional detail is provided in the Park Briefs in the appendixes.

Table 3. Percentage of segments with invasive species infestations by park.

Park Code	% of segments infested
REDW	63
ORCA	45
LABE	33
WHIS	23
CRLA	4
LAVO	0

Crater Lake was sampled between July 28 and July 31 then again from August 29 to September 11. The lower elevations were completed first, to capture the peak flowering season for most invasive species, and 28 segments, or 71.3 road and trail kilometers, were surveyed. The Crater Lake effort recorded one of the 27 prioritized early detection invasive species across the park. Ox eye daisy (*Leucanthemum vulgare*) was the only prioritized invasive species observed. Table 2 shows the percentage of segments infested.

Lava Beds was sampled between June 1 and June 9, the height of the flowering season for most invasive species, and 27 segments, or 63.4 road and trail kilometers, were surveyed. The Lava Beds effort recorded eight of the 17 prioritized early detection invasive species across the park. The species, by descending abundance, included: goat's beard (*Tragopogon dubius*), sweet clover (*Melilotus* spp.), Medusahead (*Taeniatherum caput-medusae*), Canada thistle (*Cirsium arvense*), flix weed (*Descurainia sophia*), pepperweed (*Lepidium latifolium*), Russian thistle (*Salsola tragus*), and mullein (*Verbascum thapsus*). Table 2 shows the percentage of segments infested by each species.

Lassen Volcanic was sampled between July 10 and July16, and then again between July 24 and July 28, the height of the flowering season for most invasive species. Thirty-three segments, or 82.3 road and trail kilometers, were sampled. The Lassen effort recorded none of the 37 prioritized early detection invasive species across the park.

Oregon Caves was sampled between June 6 and June 9, to capture the peak flowering season for most invasive species, and 11 segments, or 11.9 road and trail kilometers, were surveyed. The Oregon Caves effort recorded three of the six prioritized early detection invasive species across the park . The species, listed by descending abundance include: Klamath weed (*Hypericum perforatum*), orchard grass (*Dactylis glomerata*), and cheatgrass (*Bromus tectorum*). Table 2 shows the percentage of segments infested by each species.

Redwood was sampled between July 14 and August 3 then again from September 11 to September 14, to capture the peak flowering season for most invasive species. Forty segments, or 108.2 road and trail kilometers, were surveyed. The Redwood effort recorded 11 of the 39 prioritized early detection invasive species across the park. The species listed in decreasing abundance included: pampas grass (*Cortaderia* spp.), Klamath weed (*Hypericum perforatum*), bull thistle (*Cirsium vulgare*), foxglove (*Digitalis purpurea*), scotch broom (*Cytisus scoparius*), tansy ragwort (*Senecio jacobaea*), Canada thistle (*Cirsium arvense*), herb Robert (*Geranium robertianum*), holly (*Ilex aquifolium*), cut-leaved blackberry (*Rubus laciniatus*), and Himalayan blackberry (*Rubus discolor*). Table 2 shows the percentage of segments infested by each species.

Whiskeytown was sampled between May 4 and May 21 then again from June 22 to June 25. The lower elevations were completed first to capture the peak flowering season for most invasive species and 30 segments, or 57.2 road and trail kilometers, were surveyed. The Whiskeytown effort recorded nine of the 48 prioritized early detection invasive species across the park. The species, listed in decreasing abundance included: cheatgrass (*Bromus tectorum*), red brome (*Bromus rubens*), bull thistle (*Cirsium vulgare*), knapweed/star thistle (*Centaurea* spp.), soft chess (*Bromus hordeaceus*), ripgut brome (*Bromus diandrus*), Scotch broom (*Cytisus scoparius*), Klamath weed (*Hypericum perforatum*), and sheep sorrel (*Rumex acetosella*). Table 2 shows the percentage of segments infested by each species.

Discussion

Priority Species

Minor changes were made to the list of target invasive species prior to field sampling, largely to reflect changes to the invasion phase of certain species based on current information. As the floristic composition of all landscapes is constantly in flux, we expect that our prioritized lists of invasive species will need to be adjusted periodically to reflect on-the-ground conditions. We recommend that, before each monitoring season, Klamath Network personnel discuss with park personnel the proposed list of invasive species to be monitored and make adjustments as necessary. Although changes in the list will weaken comparisons across years for individual species, they will ensure that this management protocol is targeted towards the highest priority threats over time. At some point in the future, a more formal prioritization like that undertaken by Klinger and Brooks (2008) should be undertaken. This will require additional funding.

The complete absence of invasive species in our 788 randomly-placed plots was somewhat surprising. Our random plots have a radius of 5.65 m, with the center placed from 6-14 m from a road or trail. Thus with plots having the possibility of being placed in the area where infestations occur most frequently (<6 m), had there been a problem of overlooked infestations, we probably would have encountered some in random plots. Thus, we feel confident that our detection distance (even though occasionally very limited) was adequate to observe nearly all infestations along the corridors we traveled. We conclude that the method is generally reliable and also that for locally rare biologically important species like invasives, targeted methods like this protocol are much more efficient than purely random sample placement. It is likely that detection of infestations will be hampered by poor visibility through dense vegetation and potentially that some crew members will prove better at detecting invasive species than others. In the future, we may want to analyze the role of detection distance and differences in crew member observations of invasive species, as is done with avifauna (Buckland et al. 2001).

We found that roads, as the main transportation corridors in the parks, had significantly more invasive species infestations than did trails. It is likely that roads are the areas of greatest propagule pressure by invasive species, due to the likelihood of species being dispersed by vehicles. They are often also areas with notably different abiotic conditions. Typically, road corridors have greater light availability and the roadsides often have more frequent disturbance of greater magnitude caused by greater resources (water, nutrients) from under the road prism or due to runoff from it. It is unknown how many species will colonize along roads and then expand through the parks, given the distinctiveness of the roadside habitat. However, our findings justify targeting these areas as focal locations for early detection monitoring.

Our findings also suggest that invasion is strongly correlated with distance to road or trail. Likely causes of this finding are increased propagule pressure near transportation corridors and also greater resource availability. For example, water and nutrient levels are higher next to roads, as discussed above. In addition, we found that most invasives occurred in full sunlight or only minimal overstory cover. Trailsides and particularly roadsides have greater light levels due to the opening in the vegetation canopy created by the road or trail and this effect is greatest closer to the road or trail. We did, however, find a number of species (e.g., holly at REDW) that are shade tolerant. Martin et al. (2009) point out how these may be the invasive species of greatest concern because they are capable of invading in the

absence of disturbance. This is a particular concern with species like holly at Redwood because it has bright red berries and bird dispersed the seeds. Such species will likely require much more extensive surveys to detect and control.

At Lassen Volcanic, our crew likely recorded anomalously low levels of infestation, as the sampling followed invasive plant control efforts undertaken earlier in the summer. Janet Coles, Vegetation Ecologist for LAVO, said that before we began sampling at the park, crews implemented management actions in an effort to control the following invasive species: common mullein (*Verbascum thapsus*), bull thistle (*Cirsium vulgare*), smooth brome (*Bromus inermis*), intermediate wheatgrass (*Elytrigia intermedia*), dyer's woad (*Isatis tinctoria*), and cheatgrass (*Bromus tectorum*). Of these six species, four were among those we prioritized for monitoring; dyer's woad and cheatgrass are monitored throughout the park, while we monitor bull thistle and mullein only in the backcountry. Thus, while the species distribution pattern we found of more invasives at lower elevations does hold true, our finding of a total lack of invasive species presence at Lassen Volcanic is likely due to the recent management and does not reflect an environment entirely unsuitable for invasive species of early detection interest.

The Klamath Network ISED Protocol proved to be efficient and effective in detecting infestations of the target species. It allowed sampling of a large array or road and trail corridors in all parks of the Klamath Network with a two person field crew in one field season, resulting in hundreds of georeferenced invasive plant infestations to target for control or eradication. It appears to be an important addition to park-based monitoring and control efforts, and with continued support and assistance from park managers, should aid in the protection of park resources.

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Appendix A: Crater Lake National Park

Fiscal Year 2009 Accomplishments

The Klamath I&M program implemented the first season of its Invasive Species Early Detection Protocol from April to September 2009. During the season, a two person crew led by Sean Smith visited all six parks in the Klamath Network, beginning the season in Whiskeytown NRA and concluding in Redwood NSP. The crew visited 170 road and trail segments for a total of 395 km. The sample effort matched or exceeded expectations, which was particularly heartening for the first full season of implementation. This represents the first quantitative sample of all six parks in the Network using a repeatable, peer-reviewed methodology at comparable intensities. Data are under analysis and a full report, including shapefiles of invasive species locations, for all six parks is in preparation.

Park-specific Findings

Crater Lake was sampled between July 28 and July 31 then again from August 29 to September 11. The lower elevations were completed first, to capture the peak flowering season for most invasive species, and 28 segments or 71.3 road and trail kilometers were surveyed. The Crater Lake effort recorded 1 of the 27 prioritized early detection invasive species across the park. ox eye daisy (*Leucanthemum vulgare*) was the only prioritized invasive species observed. Table 1 shows the percentage of segments infested.

Table 1. Summary of prioritized invasive species at Crater Lake NP.

Species	Total # of infestations	# of segments infested	% of segments infested
Leucanthemum vulgare	1	1	3.57

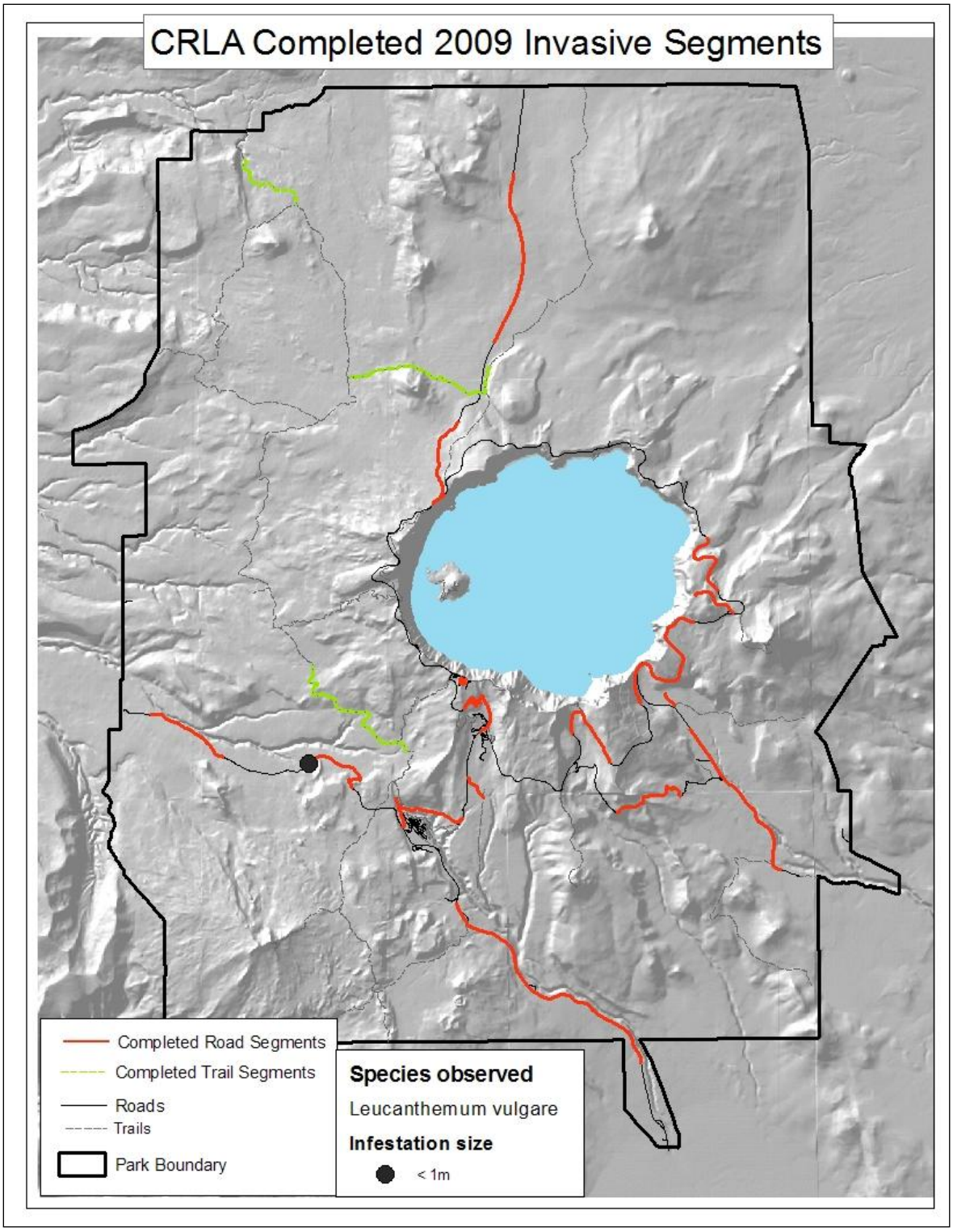

Figure 1. Locations of invasive plant species recorded in FY 2009 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year.

Appendix B: Lava Beds National Monument

Fiscal Year 2009 Accomplishments

The Klamath I&M program implemented the first season of its Invasive Species Early Detection Protocol from April to September 2009. During the season, a two person crew led by Sean Smith visited all six parks in the Klamath Network, beginning the season in Whiskeytown NRA and concluding in Redwood NSP. The crew visited 170 road and trail segments for a total of 395 km. The sample effort matched or exceeded expectations, which was particularly heartening for the first full season of implementation. This represents the first quantitative sample of all six parks in the Network using a repeatable, peer-reviewed methodology at comparable intensities. Data are under analysis and a full report, including shapefiles of invasive species locations, for all six parks is in preparation.

Park-specific Findings

Lava Beds was sampled between June 1 and June 9, the height of the flowering season for most invasive species, and 27 segments or 63.4 road and trail kilometers were surveyed. The Lava Beds effort recorded 8 of the 17 prioritized early detection invasive species across the park. The species, by descending abundance, included: goat's beard (*Tragopogon dubius*), sweet clover (*Melilotus* sp.), medusa head (*Taeniatherum caput-medusae*), Canada thistle (*Cirsium arvense*), flix weed (*Descurainia sophia*), pepperweed (*Lepidium latifolium*), Russian thistle (*Salsola tragus*), and mullein (*Verbascum thapsus*). Table 1 shows the percentage of segments infested by each species.

Table 1. Summary of prioritized invasive species at Lava Beds NM. Note an * indicates species only surveyed in wilderness areas.

Species	Total # of infestations	# of segments infested	% of segments infested
*Tragopogon dubius**	18	3	11.11
Melilotus sp.	8	3	11.11
Taeniatherum caput-medusae	7	3	11.11
Cirsium arvense	4	1	3.70
*Descurainia sophia**	4	1	3.70
Lepidium latifolium	1	1	3.70
Salsola tragus	1	1	3.70
*Verbascum thapsus**	1	1	3.70

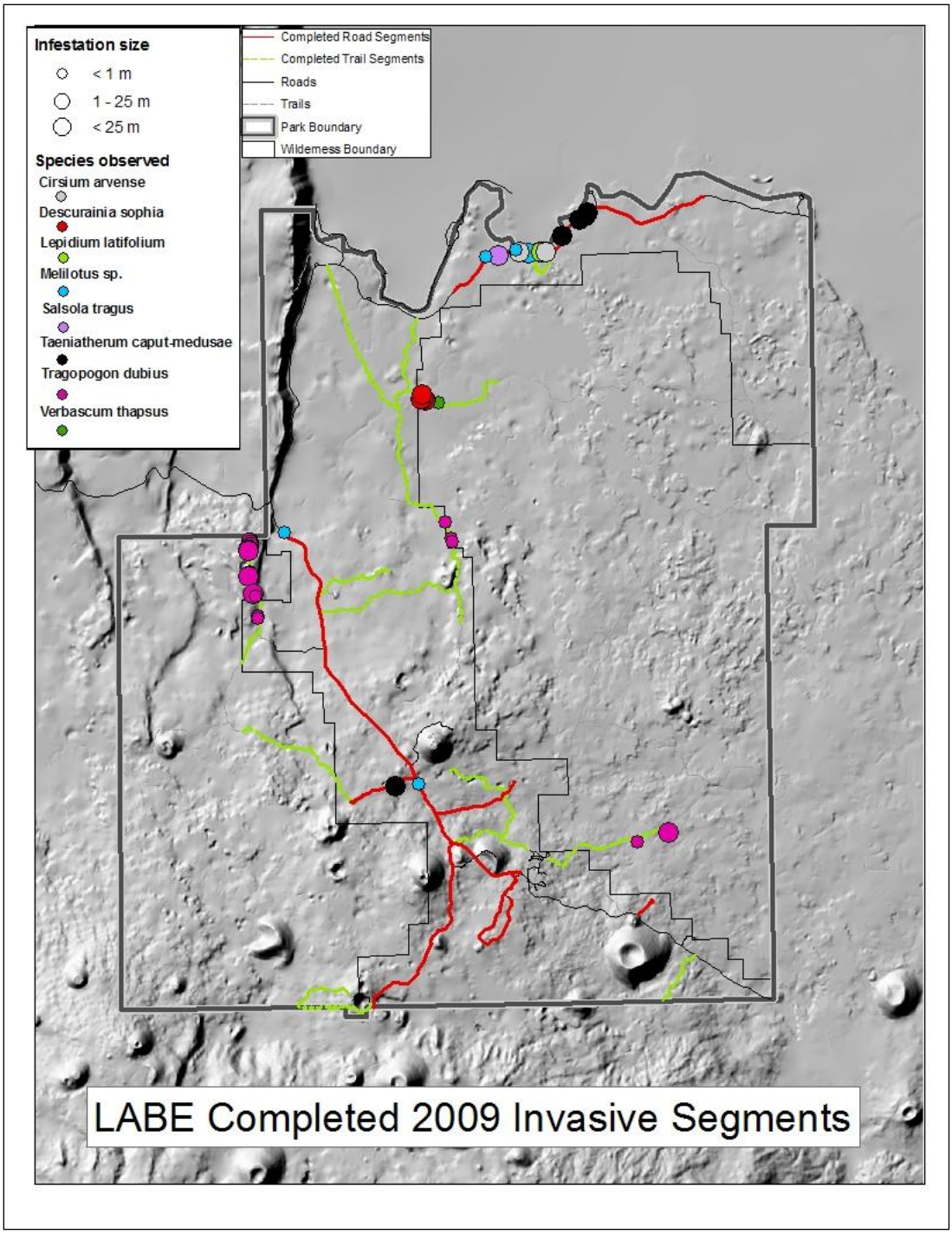

Figure 1. Locations of invasive plant species recorded in FY 2009 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year, and in 2009 no sites at Petroglyph Point were selected to survey.

Appendix C: Lassen Volcanic National Park

Fiscal Year 2009 Accomplishments

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Park-specific Findings

Lassen was sampled between July 10 and July16, and then again between July 24 and July 28, the height of the flowering season for most invasive species. Thirty three segments or 82.3 road and trail kilometers (Figure 1.) were sampled. The Lassen effort recorded none of the 37 prioritized early detection invasive species across the park.

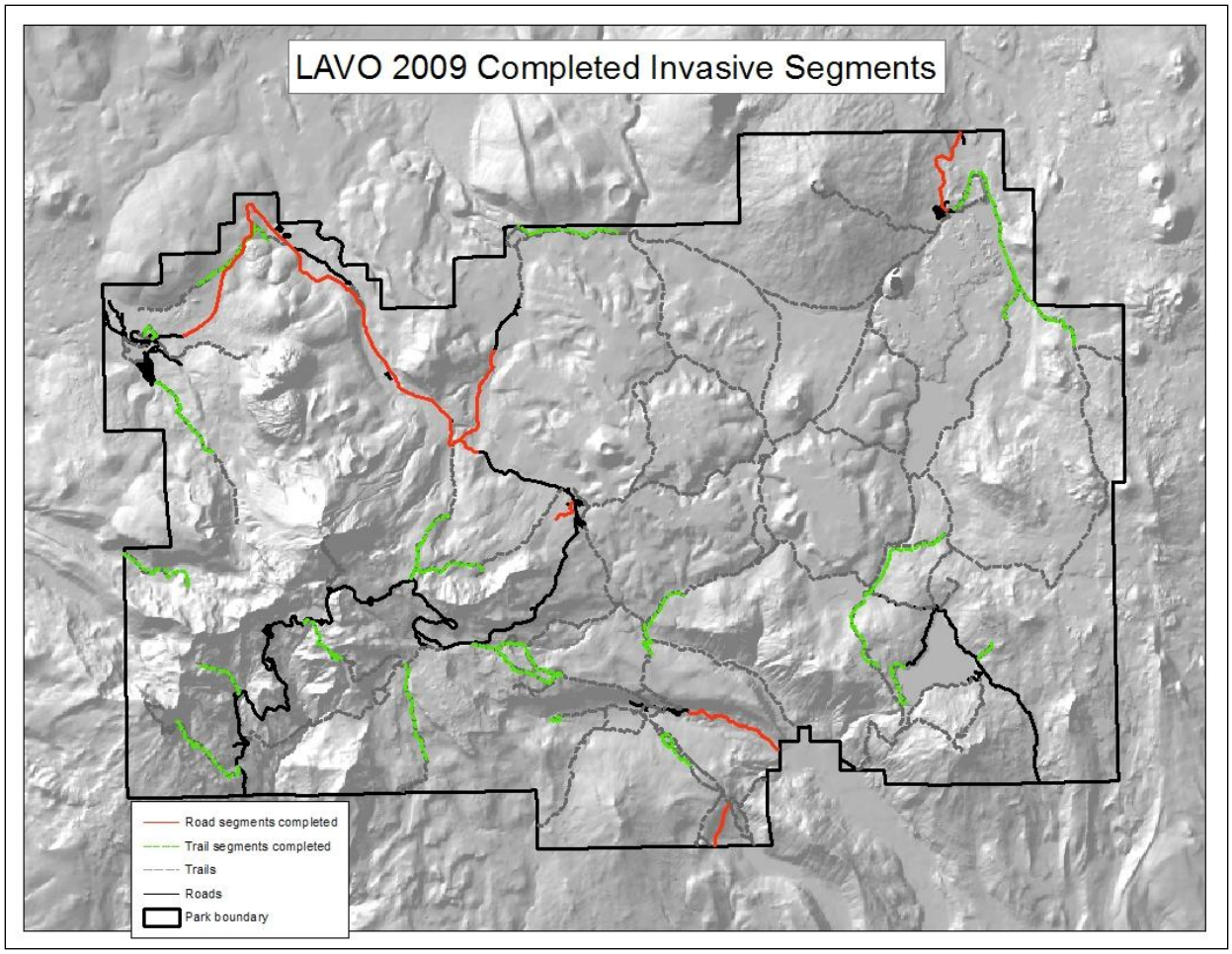

Figure 1. Locations of invasive plant species recorded in FY 2009 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year.

Appendix D: Oregon Caves National Monument

Fiscal Year 2009 Accomplishments

The Klamath I&M program implemented the first season of its Invasive Species Early Detection Protocol from April to September 2009. During the season, a two person crew led by Sean Smith visited all six parks in the Klamath Network, beginning the season in Whiskeytown NRA and concluding in Redwood NSP. The crew visited 170 road and trail segments for a total of 395 km. The sample effort matched or exceeded expectations, which was particularly heartening for the first full season of implementation. This represents the first quantitative sample of all six parks in the Network using a repeatable, peer-reviewed methodology at comparable intensities. Data are under analysis and a full report, including shapefiles of invasive species locations, for all six parks is in preparation.

Park-specific Findings

Oregon Caves was sampled between June 6 and June 9, to capture the peak flowering season for most invasive species, and 11 segments or 11.9 road and trail kilometers were surveyed. The Oregon Caves effort recorded 3 of the 6 prioritized early detection invasive species across the park . The species, listed by descending abundance include: Klamath weed (*Hypericum perforatum*), orchard grass (*Dactylis glomerata*), and cheatgrass (*Bromus tectorum*). Table 1 shows the percentage of segments infested by each species.

Table 1. Summary of Prioritized invasive species at Oregon Caves NP.

Species	Total # of infestations	# of segments infested	% of segments infested
Hypericum perforatum	7	4	36.36
Dactylis glomerata	3	3	27.27
Bromus tectorum	1	1	9.09

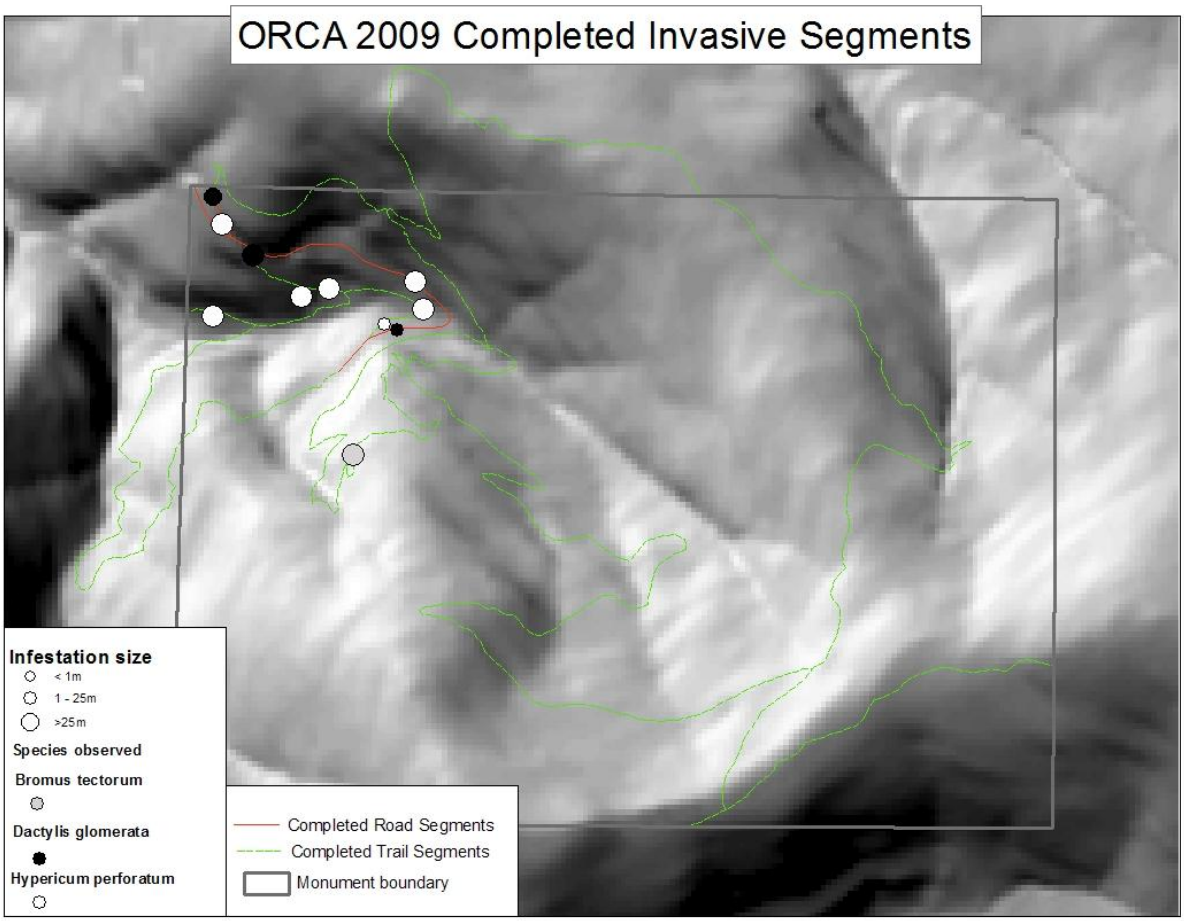

Figure 1. Locations of invasive plant species recorded in FY 2009 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year.

Appendix E: Redwood National and State Park

Fiscal Year 2009 Accomplishments

The Klamath I&M program implemented the first season of its Invasive Species Early Detection Protocol from April to September 2009. During the season, a two person crew led by Sean Smith visited all six parks in the Klamath Network, beginning the season in Whiskeytown NRA and concluding in Redwood NSP. The crew visited 170 road and trail segments for a total of 395 km. The sample effort matched or exceeded expectations, which was particularly heartening for the first full season of implementation. This represents the first quantitative sample of all six parks in the Network using a repeatable, peer-reviewed methodology at comparable intensities. Data are under analysis and a full report, including shapefiles of invasive species locations, for all six parks is in preparation.

Park-specific Findings

Redwood was sampled between July 14 and August 3 then again from Sept 11 to Sept. 14, to capture the peak flowering season for most invasive species. Forty segments or 108.2 road and trail kilometers were surveyed. The Redwood effort recorded 11 of the 39 prioritized early detection invasive species across the park . The species listed in decreasing abundance included: pampas grass (*Cortaderia* spp.), Klamath weed (*Hypericum perforatum*), bull thistle (*Cirsium vulgare*), fox glove (*Digitalis purpurea*), scotch broom (*Cytisus scoparius*), tansy ragwort (*Senecio jacobae*), Canada thistle (*Cirsium arvense*), herb Robert (*Geranium robertianum*), holly (*Ilex aquifolium*), cut-leaved blackberry (*Rubus laciniatus*), Himalayan blackberry (*Rubus discolor*). Table 1 shows the percentage of segments infested by each species.

Table 1. Summary of Prioritized invasive species at Redwood NSP. Note * indicates species only monitored in the Backcountry.

Species	Total # of infestations	# of segments infested	% of segments infested
Cortaderia spp.	47	13	32.5
Hypericum perforatum	42	12	30
Cytisus scoparius	6	4	10
*Cirsium vulgare**	21	2	5
*Digitalis purpurea**	9	2	5
Cirsium arvense	4	2	5
*Senecio jacobaea**	4	2	5
Ilex aquifolium	2	2	5
Geranium robertianum	3	1	2.5
Rubus laciniatus	2	1	2.5
*Rubus discolor**	1	1	2.5

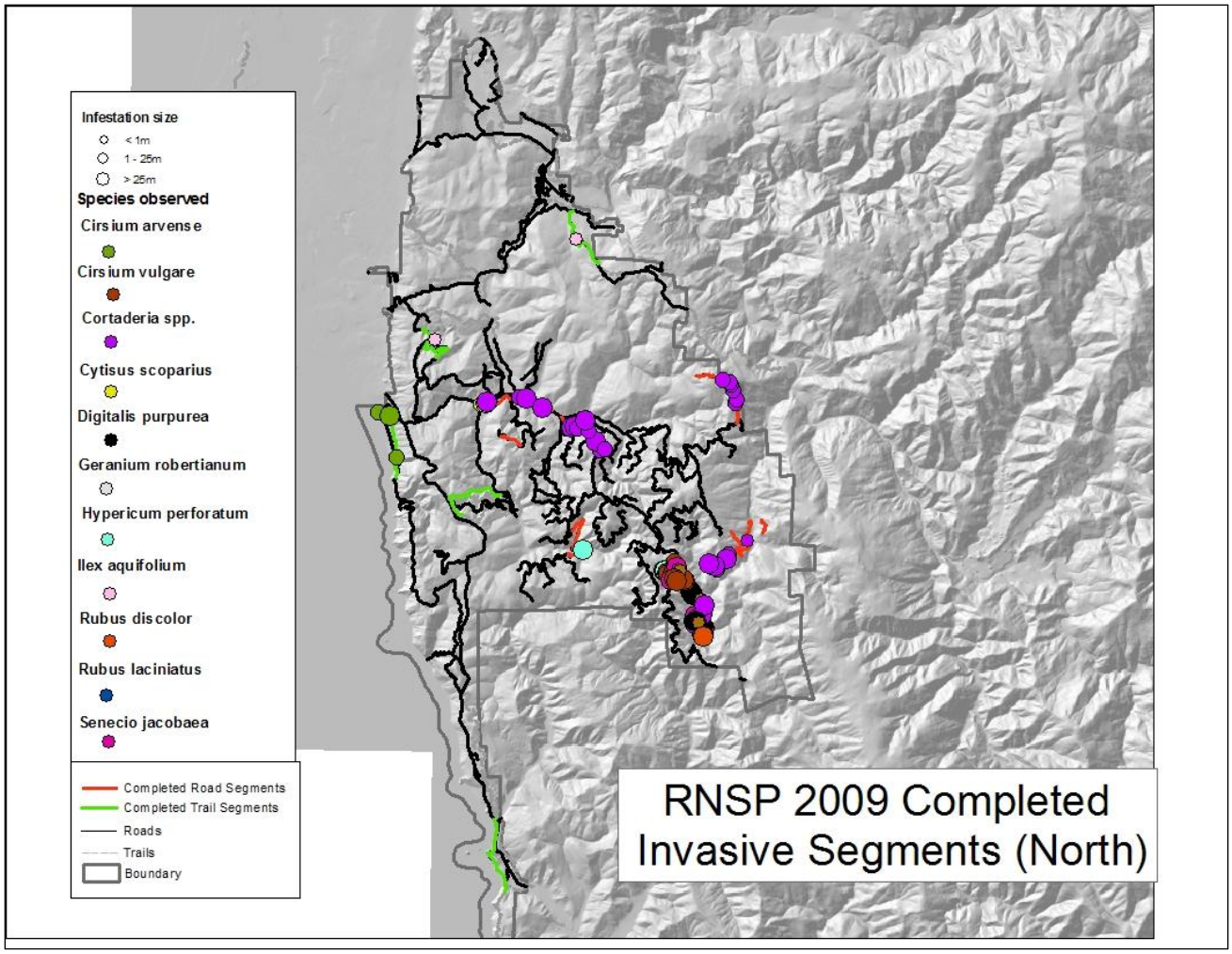

Figure 1. Locations of invasive plant species recorded in FY 2009 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year.

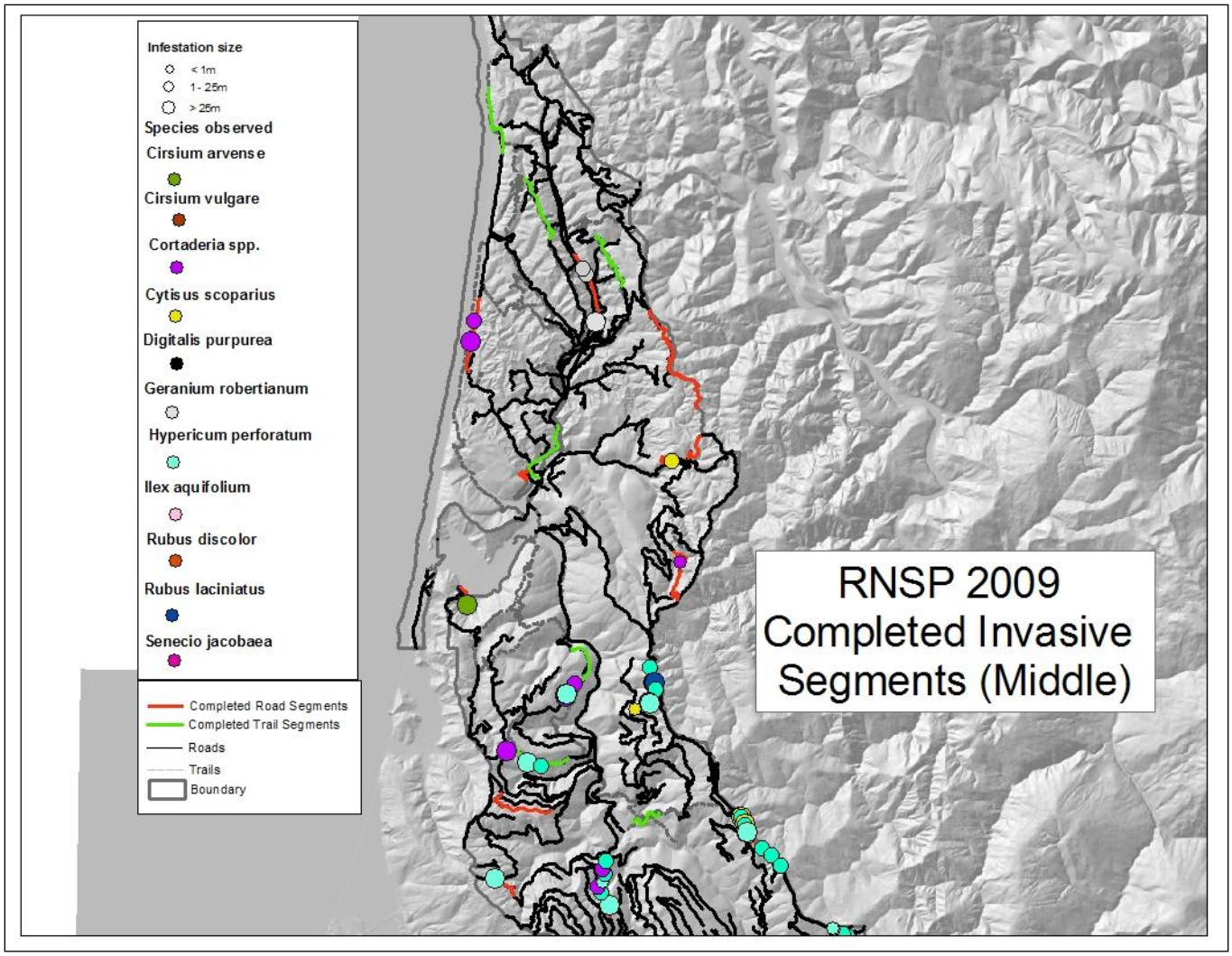

Figure 1. Locations of invasive plant species recorded in FY 2009 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year (continued).

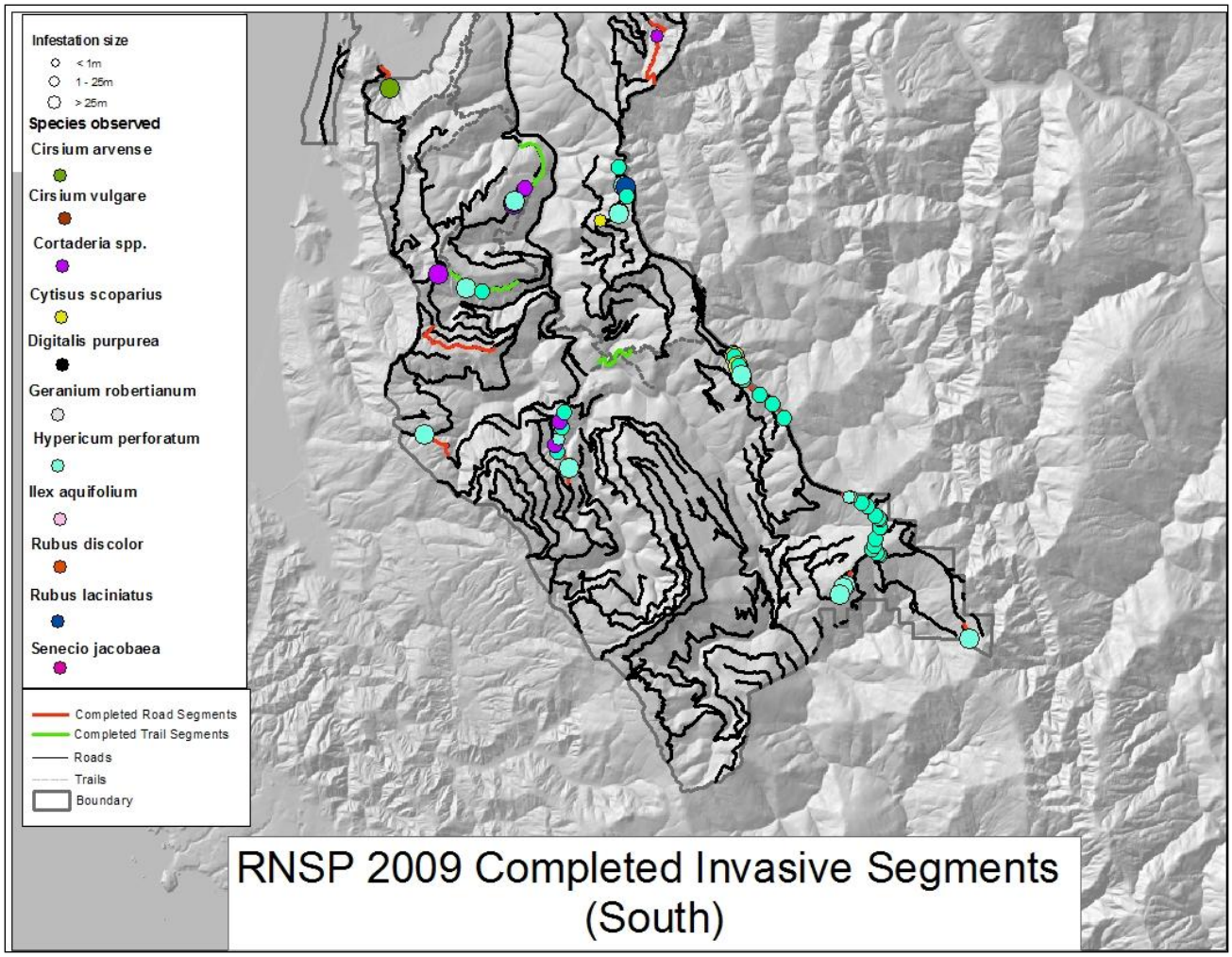

Figure 1. Locations of invasive plant species recorded in FY 2009 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year (continued).

Appendix F: Whiskeytown National Recreation Area

Fiscal Year 2009 Accomplishments

The Klamath I&M program implemented the first season of its Invasive Species Early Detection Protocol from April to September 2009. During the season, a two person crew led by Sean Smith visited all six parks in the Klamath Network, beginning the season in Whiskeytown NRA and concluding in Redwood NSP. The crew visited 170 road and trail segments for a total of 395 km. The sample effort matched or exceeded expectations, which was particularly heartening for the first full season of implementation. This represents the first quantitative sample of all six parks in the Network using a repeatable, peer-reviewed methodology at comparable intensities. Data are under analysis and a full report, including shapefiles of invasive species locations, for all six parks is in preparation.

Park-specific Findings

Whiskeytown was sampled between May 4 and May 21 then again from June 22 to June 25. The lower elevations were completed first to capture the peak flowering season for most invasive species and 30 segments or 57.2 road and trail kilometers were surveyed. The Whiskeytown effort recorded 9 of the 48 prioritized early detection invasive species across the park. The species, listed in decreasing abundance included: cheatgrass (*Bromus tectorum*), red brome (*Bromus rubens*), bull thistle (*Cirsium vulgare*), knapweed/star thistle (*Centaurea* spp.), soft chess (*Bromus hordeaceus*), ripgut brome (*Bromus diandrus*), Scotch broom (*Cytisus scoparius*), Klamath weed (*Hypericum perforatum*), and sheep sorrel (*Rumex acetosella*). Table 1 shows the percentage of segments infested by each species.

Table 1. Summary of prioritized invasive species at Whiskeytown NRA. Note * indicates species only surveyed above 2500ft.

Species	Total # of infestations	# of segment infestations	% of segments infested
*Bromus tectorum**	11	2	6.67
*Bromus rubens**	5	2	6.67
Cirsium vulgare	4	2	6.67
Centaurea sp.	3	2	6.67
*Bromus hordeaceus**	2	1	3.33
*Bromus diandrus**	1	1	3.33
Cytisus scoparius	1	1	3.33
*Hypericum perforatum**	1	1	3.33
*Rumex acetosella**	1	1	3.33

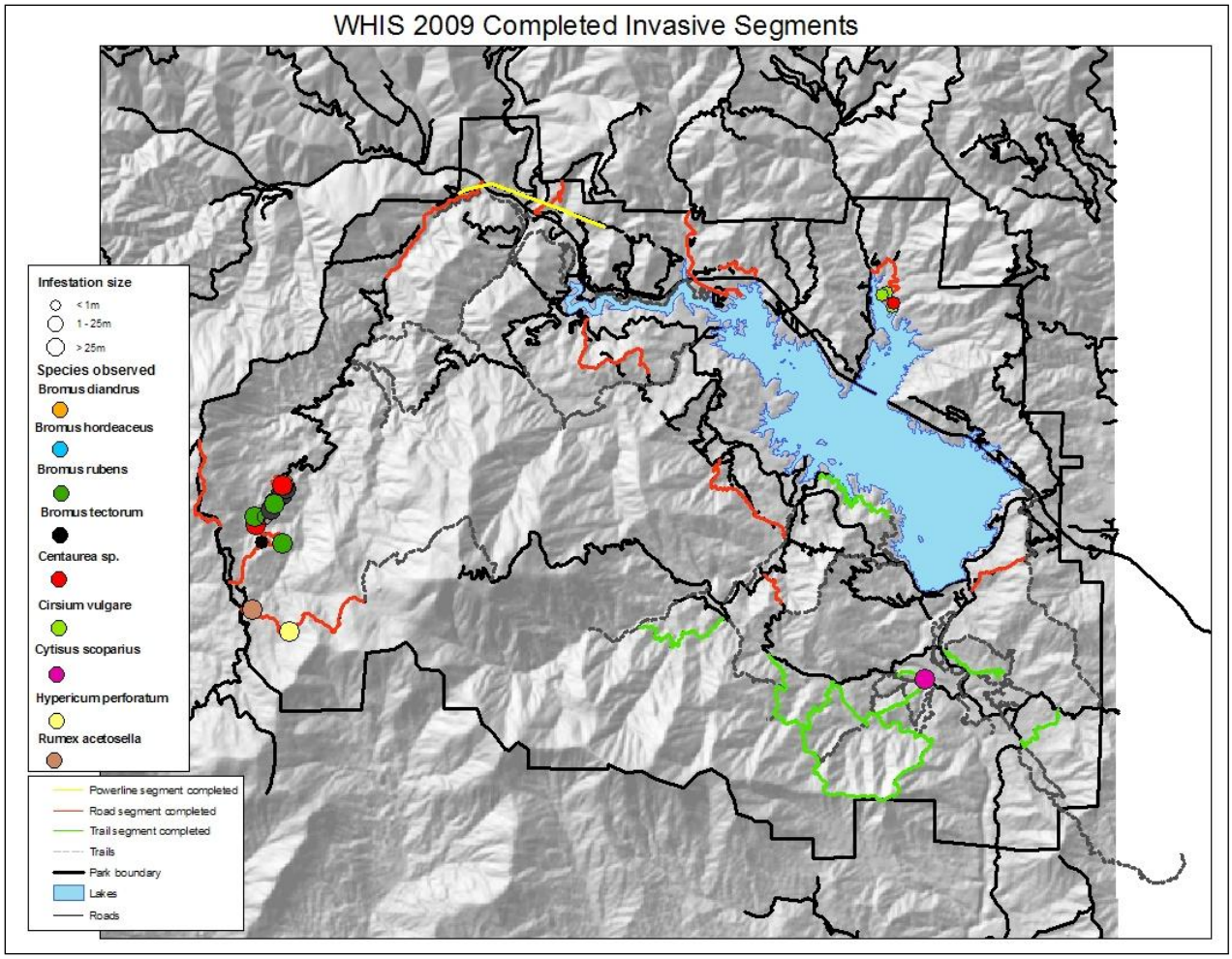

Figure 1. Locations of invasive plant species recorded in FY 2009 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year.

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